Two Case Studies of Proton Exchange Membrane (PEM) Fuel Cell Installations

United States Army Corps of Engineers
ERDC/CERL

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2005 Fuel Cell Seminar

Palm Springs, CA
14-18 November 2005

Presentation Outline

- Introduction to PEM Demonstration
- Fort Lewis Army Base, WA
- Montana Army National Guard, MT
- Questions

DoD Residential PEM Demonstration

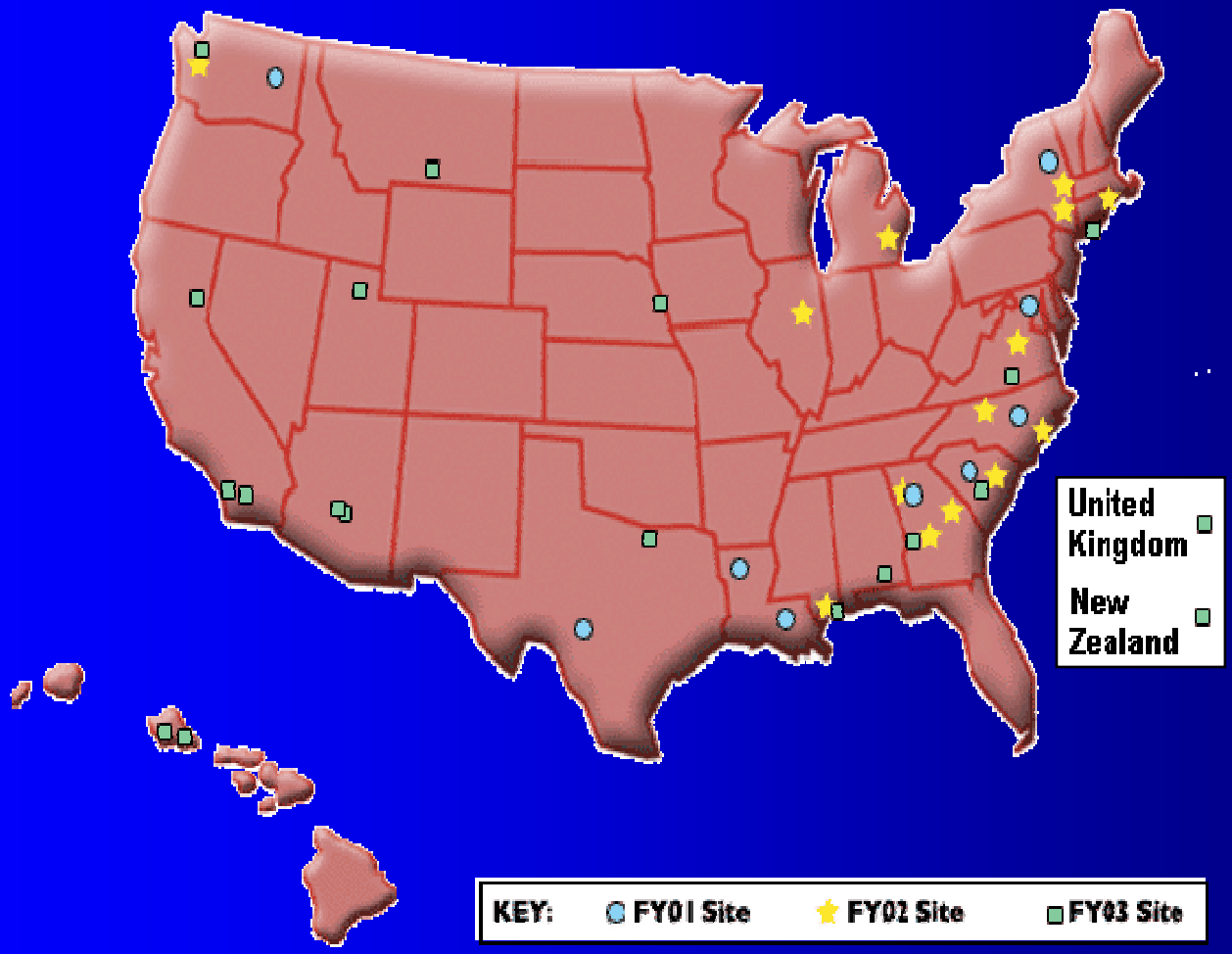
BAA Requirements

- "Domestically Produced" PEM Units, 1 kW to 20 kW
- US Military Facilities/Embassies, etc.
- Turn-key Packages Requested
- Maximum Diversity Desired
- 1 Year of "Fuel Cell Power" Required
  - (90% Availability)

DoD Residential PEM Demonstration

- 83 PEM units at 42 sites
- Funding:
  - ✓ FY04 ~$ 1.6M
  - ✓ FY03 ~$ 3.6M
  - ✓ FY02 ~$ 3.4M
  - ✓ FY01 ~$ 3.6M
- No Cost-Share Required

FY01-FY03 Residential PEM Project Sites



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FY01-FY03 Residential PEM Program Manufacturer Unit Totals

Fiscal Year	Plug Power (No. Units)	ReliOn, Inc. Formerly Avista Labs (No. Units)	IdaTech (No. Units)	Nuvera (No. Units)	Totals (No. Units)
FY01	20	1	0	0	21
FY02	23	1	0	2	26
FY03	14	11	4	0	29
Totals	57	13	4	2	76

DoD Residential PEM Program

Fleet Performance Summary

January 15, 2002 - October 31, 2005

Program Performance Matrix						
Program Year	Total Run Hours	Availability (%)	Capacity Factor (%)	Total Energy Produced (kWe-hrs)	Average Output (kW)	Electrical Efficiency (%)
FY01	171,826	89.4%	47.3%	450,547	2.62	23.6%
FY02	184,521	88.4%	43.8%	461,061	2.50	24.1%
FY03	87,521	82.8%	27.0%	200,192	2.29	23.6%
Program Totals/Averages	443,868	87.6%	33.2%	1,111,801	2.50	23.8%

DoD Residential PEM Program

Fleet Performance Summary

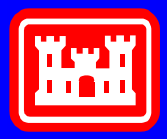
January 15, 2002 - October 31, 2005

- **Electrical Efficiency**

Natural Gas	24.13%
Hydrogen	27.83%
Propane	23.08%

- **Thermal Efficiency**

Natural Gas	10.66%
Propane	9.22%



DoD Residential PEM Program

Fleet Performance Summary

January 15, 2002 - October 31, 2005

- **Scheduled Outages**

Number of Outages	123
Total Duration	5,880 Hrs
Mean Time	47.81 Hrs

- **Unscheduled Outages**

Number of Outages	719
Total Duration	37,459 Hrs
Mean Time	52.10 Hrs

Demonstration Purpose

- Simulate DC Powered System with Battery Backup
- Demonstrate Fuel Cell Capability as Backup Power
- Demonstrate Fuel Cell Automatic Startup Capability
- Advance PEM Technology
- Promote PEM Marketplace Penetration

Ft. Lewis Army Base Demonstration

• Proposer	ReliOn Inc.
• Location	Gray Army Airfield Ft. Lewis Army Base Tacoma, WA
• Fuel Cells	ReliOn I-1000
– Power Output	1kW
• Fuel Cell Load	Backup Power for Instrument Landing System (ILS)
• Installation Date	July 16, 2004

Independence1000™ Fuel Cell Statistics

Product Specifications		Independence 1000™
Physical	Dimensions	17.25"w x 25.12" d x 20.5" h (44cm w x 70cm d x 51cm h)
	Weight	152 lbs / 69 kg
	Mounting	19" or 24" rack mount configurations
Performance	Rated net power	Continuous 1000 Watts*
	Rated current	40A, 20A or 8A, depending on voltage
	DC voltage range	24, 48, or 125 VDC nominal
	Estimated MTBF	40,000 hours
Fuel	Composition	Standard industrial grade hydrogen (99.95%)
	Supply pressure to unit	25 to 100 psig 172 to 689 KPag 1.72 bar to 6.89 bar
	Consumption	7.5 slpm @ 500 Watts 15 slpm @ 1000 Watts
	Hydrogen Storage Capacity	N/A
Operation	Ambient temperature	0˚C to 46˚C 32˚F to 115˚F
	Relative humidity	0-90%
	Altitude	-197 ft. to 13,800 ft.
	Location	Indoors
Safety	Compliance	CSA CE
Emissions	Water	Max. 30mL / kWh
	Noise	53 dBA @ 1 meter

* 1000 Watts 0˚C to 40˚C; 850 Watts at 46˚C

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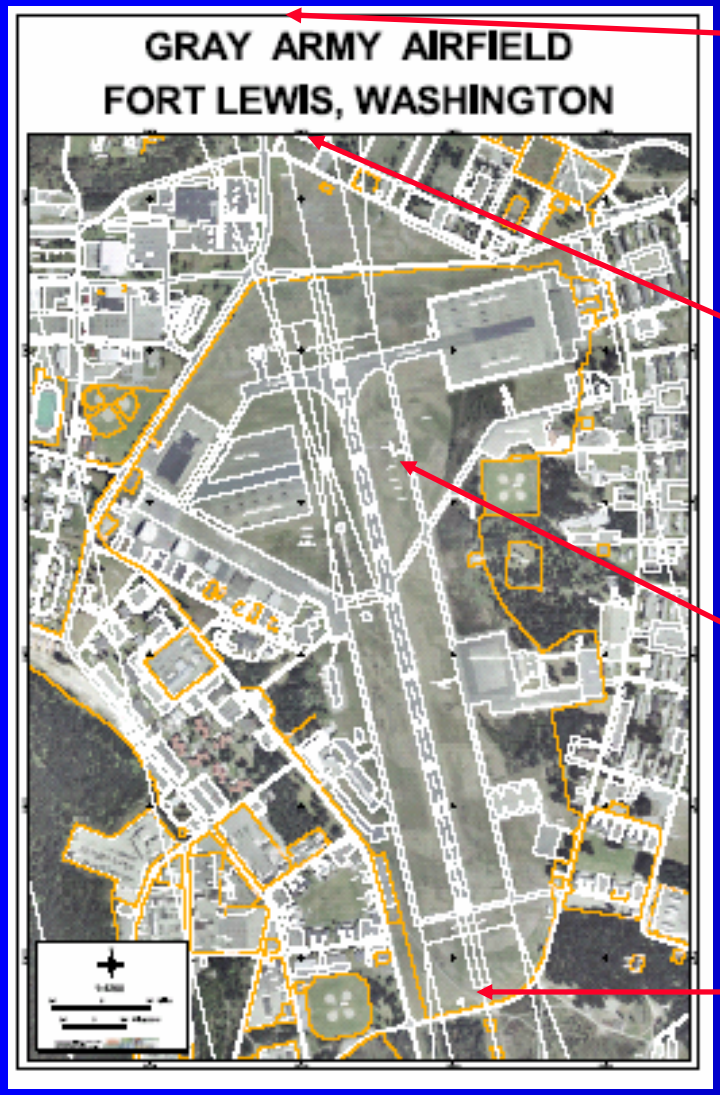
Fuel Cell System Locations



Outer Marker Beacon

Middle Marker Beacon

Glide Slope

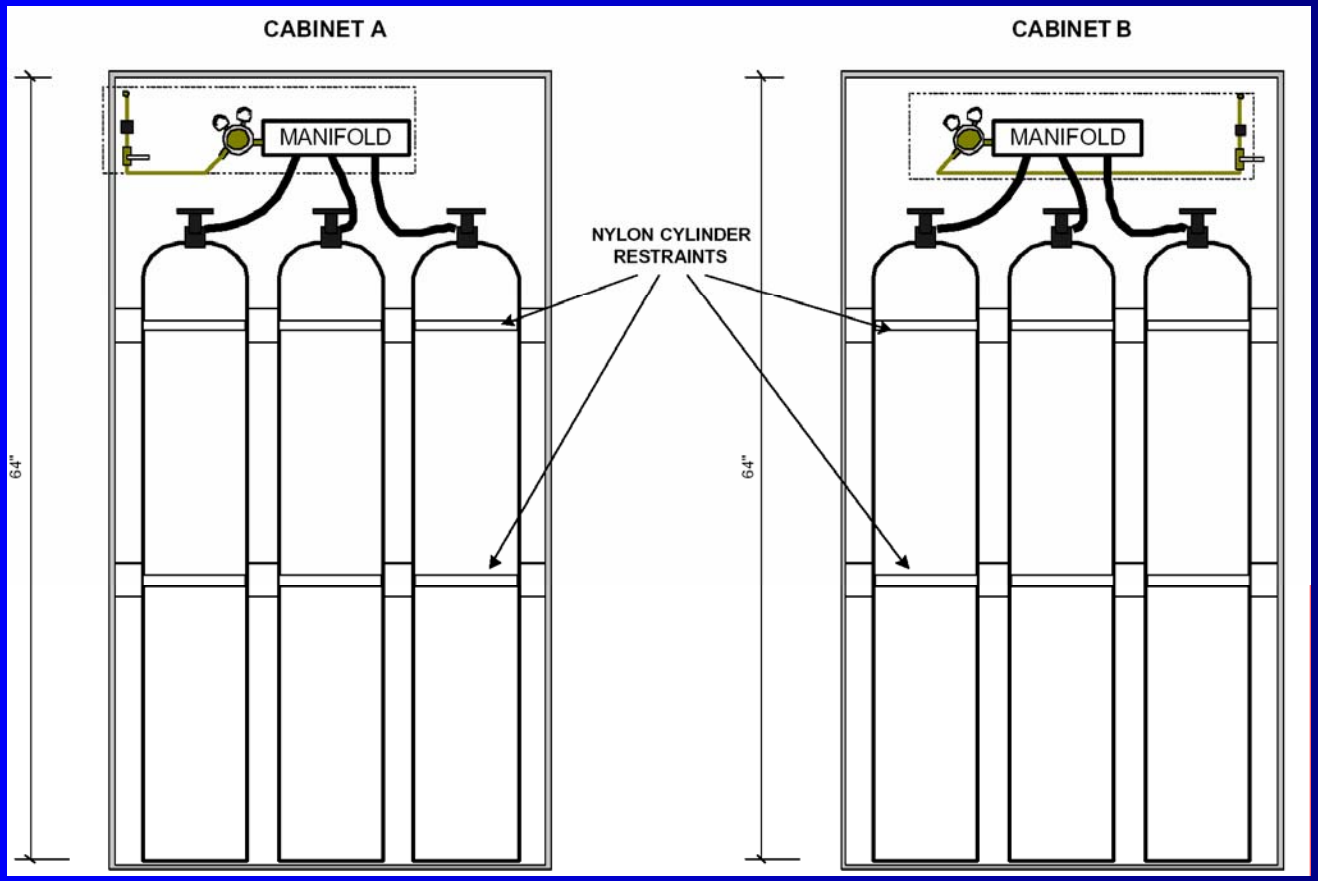
Localizer

Fuel Cell System Operating Procedure

- 60 Minute AC Grid Power Loss Simulation
  - 1Time Per Day
  - 7 Days Per Week
- Automatic Startup of Fuel Cell System
  - Provide Power to Load
- Monitor Commercial AC Grid for Power Failure
  - Upon Failure
  - Automatic Startup of Fuel Cell System
    - Provide 48kWh to Critical Equipment

Hydrogen Supply System

- Industrial Grade Hydrogen
  - Six 285 ft^3 Bottles
  - LHV 266.3(Btu/scf)
- 48 kWh Total Capacity
- Delivery Every Six Weeks



Fort Lewis Performance Summary

(4 Units)

July 16, 2004 – August 31, 2005

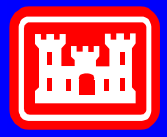
Total Run Time	1,573 hrs
Attempted Start Ups	1,592
Actual Start Ups	1,569
Reliability	98.6%
Availability	98.8%
Capacity Factor	0.6%
Total Electric Output	229.6 kWh
Avg. Output for Site	0.15 kW
Electrical Efficiency	18.7%

Fort Lewis
Outage Summary
(4 Units)
July 16, 2004 – August 31, 2005

- Scheduled Outages 1
- Scheduled Outage Hours 0.4 Hrs
- Unscheduled Outages 23
- Unscheduled Outage Hours 24 Hrs

Montana Army National Guard Demonstration

• Proposer	Montana State University-Billings
• Location	Montana Army National Guard Billings, MT
• Fuel Cells	Plug Power GenSys™ 5CS
– Power Output	5kW
• Fuel Cell Load	Prime Power for Armed Forces Reserve Center
• Installation Date	November 16, 2004



Fuel Cell System Location

United States Armed Forces Reserve Center

US Army Corps of Engineers

Engineer Research & Development Center

Montana Army National Guard Performance Summary

November 16, 2004 – September 30, 2005

Total Run Time	7,090 hrs
Availability	97.2%
Capacity Factor	49.0%
Total Electric Output	17,893 kWh
Avg. Output for Site	2.52 kW
Electrical Efficiency	26.4%
Thermal Efficiency	20.5%

Montana Army National Guard Outage Summary

November 16, 2004 – September 30, 2005

• Scheduled Outages	4
• Scheduled Outage Hours	51.6 Hrs
• Unscheduled Outages	8
• Unscheduled Outage Hours	153.4 Hrs

www.dodfuelcell.com